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New record of *Cyanallagma demoiselle* Denck, Ehlert & Pinto, 2023 (Odonata, Zygoptera, Coenagrionidae) in southern Brazil

Mateus M. Pires[1], Lenize B. Calvão[2], Cristian C. Mendoza-Penagos[2,3], Eduardo Périco[2], Leandro Juen[1]

1 *Laboratório de Ecologia e Evolução, Programa de Pós-graduação em Ambiente e Desenvolvimento, Universidade do Vale do Taquari, Lajeado, RS, Brazil*
2 *Laboratório de Ecologia e Conservação, Programa de Pós-graduação em Ecologia, Universidade Federal do Pará, UFPA, Belém, PA, Brazil*
3 *Laboratório de Invertebrados, Programa de Pós-graduação em Ecologia, Universidade Federal do Pará, UFPA, Belém, PA, Brazil*

Corresponding author: *Mateus M. Pires (marquespiresm@gmail.com)*

Abstract. During a field expedition in the municipality of Araquari, state of Santa Catarina, southern Brazil, adults of the damselfly *Cyanallagma demoiselle* Denck, Ehlert & Pinto 2023 (Odonata, Zygoptera, Coenagrionidae) were collected. This species was recently described and reported to date for the southeastern Atlantic Forest in Brazil. Here, we recorded this species as well as its respective genus for the first time for the state of Santa Catarina, increasing its distribution range of the species to southwards and raising the number of Odonata species recorded for this state to 151.

Key words. Aquatic insects, damselfly, distribution records, Neotropical, odonates.

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INTRODUCTION

Cyanallagma Kennedy, 1920 is a genus of Neotropical damselflies (Insecta, Odonata, Zygoptera) belonging to the Ischnurinae group of the Coenagrionidae (Dijkstra et al. 2014; Bybee et al. 2021) and exclusive to South America (Ellenrieder and Garrison 2008). Currently the genus is represented by eight species (Denck et al. 2023) ranging from the central region of Brazil to southern South America (Ellenrieder and Garrison 2008; Garrison et al. 2010), suggesting a possible wide distribution range within tropical and subtropical forest (Atlantic Forest) and grassland (Cerrado and Pampa) biomes (Ellenrieder and Garrison 2008; Lozano et al. 2020; Denck et al. 2023). Species from this genus are associated with a range of lentic and lotic freshwater habitat types (e.g. streams to ponds; Bulla 1973).

Recent survey compilation efforts revealed that Odonata diversity remains largely unknown in most part of the Neotropics, including Brazil, the largest country in the region (Alves-Martins et al. 2024). Particularly in relation to the occurrence of *Cyanallagma* species in Brazil, previous records cover central and southeastern regions of the country, while in the southern region, the records are restricted to Rio Grande do Sul state, covering three species: *C. corbeti* Costa, Santos & de Souza, 2009, *C. bonariense* (Ris, 1913), and *C. trimaculatum* (Selys, 1876) (Ellenrieder and Garrison 2008; Costa et al. 2009; Dalzochio et al. 2018; Pires et al. 2018).

Recently, another species from this genus was described: *C. demoiselle* Denck, Ehlert & Pinto, 2023 (Denck et al. 2023); this species is part of a group with a complex taxonomic history, current lacking phylogenomic data on the relationships of species within the genus, and with several character impediments for identification at species-level (especially the morphological correspondence of structures of caudal appendages; Ellenrieder and Garrison 2008; Denck et al. 2023). Here, we report the occurrence of another locality record of this species in the genus for the state of Santa Catarina (SC), southern region of Brazil. In addition to the new record of *C. demoiselle* for SC, this also represents the first record of the genus for SC, which had not been reported either in the preliminary list of Odonata species for the state nor recent regional checklists in SC (Calvão et al. 2024; Pires and Périco 2024).

METHODS

Sampling occurred in the austral spring of 2017 (October), in a stream reach in Araquari municipality (northeastern Santa Catarina state; Figure 1), under SISBIO permit number 71847. Specimens were collected

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with an entomological hand net, using the fixed-area scanning method (Batista et al. 2021). Specimens were analyzed with a Leica M205 stereomicroscope equipped with a Leica DFC 450 camera and images were processed in Adobe Photoshop software. Voucher specimens are deposited in the Odonata collection of the Laboratório de Ecologia e Conservação (LABECO) of the Federal University of Pará (UFPA), Belém, Brazil.

RESULTS

***Cyanallagma demoiselle* Denck, Ehlert & Pinto, 2023**
Figures 1, 2

New record. BRAZIL – Santa Catarina state • Araquari municipality; −26.4869, −048.7455; 12 m a.s.l.; 03 October 2017; A.L. Andrade leg.; 2 ♂; LABECO ODA.GRAL3913-3914.

Identification. Specimens were identified by direct examination and comparison with the available specialized literature. The generic assignment was based on Ellenrieder and Garrison (2008) and Garrison et al. (2010). The species-level identification was made based on the original description by Denck et al. (2023). Structures such as the shape of the postocular spots, the posterior lobe of the prothorax, the coloration of the synthorax, the shape of the S2 and the apex of the genital ligula, as well as the shape of the cercus in the males, are characters of taxonomic importance in determining the species within *Cyanallagma* (Ellenrieder and Garrison 2008; Costa et al. 2009; Denck et al. 2023). The terminology used for external morphology follows Denck et al. (2023).

The specimens evaluated present the diagnostic characters of *C. demoiselle* described by Denck et al. (2023): postocular spots rounded, posterior lobe of prothorax trilobed and truncated posteriorly, second segment of genital ligula with a single mesial projection on ental transverse leaf, lateral lobes strongly rounded laterally, and apical margin concave; S10 with a pair of tubercle-like processes projecting posteriorly, cercus with inner surface without carina and a long ventro-apical process (Figure 2). However, the species showed two variations, one in the color pattern of the mesepisternum and the genital ligula. The mesepisternal stripe is almost interrupted in the posterior portion (Figure 2B). In addition, the latero-apical lobes on the genital ligula are more pronounced, reaching almost to the base of L2 of the ligula (Figure 2F).

DISCUSSION

Cyanallagma demoiselle (Figure 2) is known from two localities in the coastal zone of the São Paulo state (Denck et al. 2023). An additional potential record of *C. demoiselle* in the southeastern region of Minas Gerais state (Ouro Preto municipality), mentioned in the original description of the species, was concluded by the original authors of the species (Denck et al. 2023: 220–222, fig. 6 [map]) to most likely be a mislabeled specimen, and thus an explicitly doubtful record (Denck et al. 2023). We here provide a new locality record for *C. demoiselle* that, therefore, represents the third confirmed report of this species in Brazil.

The two males of *C. demoiselle* from Araquari exhibit diagnostic characters defined for the species, except for the coloration of the mesepisternal stripe. In its posterior portion, this stripe is almost interrupted (Figure 2B); however, one of the criteria presented by Denck et al. (2023) is that this stripe is complete and uninterrupted (Figure 2A). Variations in the coloration pattern of the mesepisternal stripe within the same species are frequent in Odonata and may be due to interspecific variation, ontogenetic changes or geographical variations. For example, in *Progomphus complicatus* Selys, 1854 there are variations in the coloration pattern of the mesepisternal stripe for two areas in southern Brazil (De Almeida et al. 2013). In several widely distributed species within the genus *Argia*, there are differences in the coloration pattern between populations (Garrison and Ellenrieder 2015; Garrison et al. 2015). Furthermore, the coloration pattern can be influenced by post-mortem effects (Suárez-Tovar et al. 2022). Given such contingencies, the use of color pattern as an informative taxonomic character can be regarded as a questionable procedure for several groups (Mendoza-Penagos et al. 2024). We therefore warn about variation in this trait (mesepisternal stripe) in *C. demoiselle*, which is important to improve future identification keys on *Cyanallagma*, a genus which we judge still lacks unequivocal morphological information for species-level identifications.

In addition, our record expands the distribution of *C. demoiselle* 170 km south in the vicinity of the coastal area of the state of Santa Catarina, representing the southernmost one in the country (Figure 1; Appendix Table A1). Although this finding still requires confirmation by future studies, the presence of *C. demoiselle* can thus be estimated for the state of Paraná, given its occurrence in areas of Restinga-like formation of the Atlantic Forest, which extends from São Paulo to Santa Catarina states (IBGE - Instituto Brasiliero de Geografia e Estatística 2019). Furthermore, based on recent taxonomic keys and previous distribution range maps for species in this genus (Ellenrieder and Garrison 2008; Costa et al. 2009; Denck et al. 2023), our report represents the first record of the genus *Cyanallagma* Kennedy, 1920 for the state of Santa Catarina. Finally, considering recent compilation of species records (Pires and Périco 2024) and

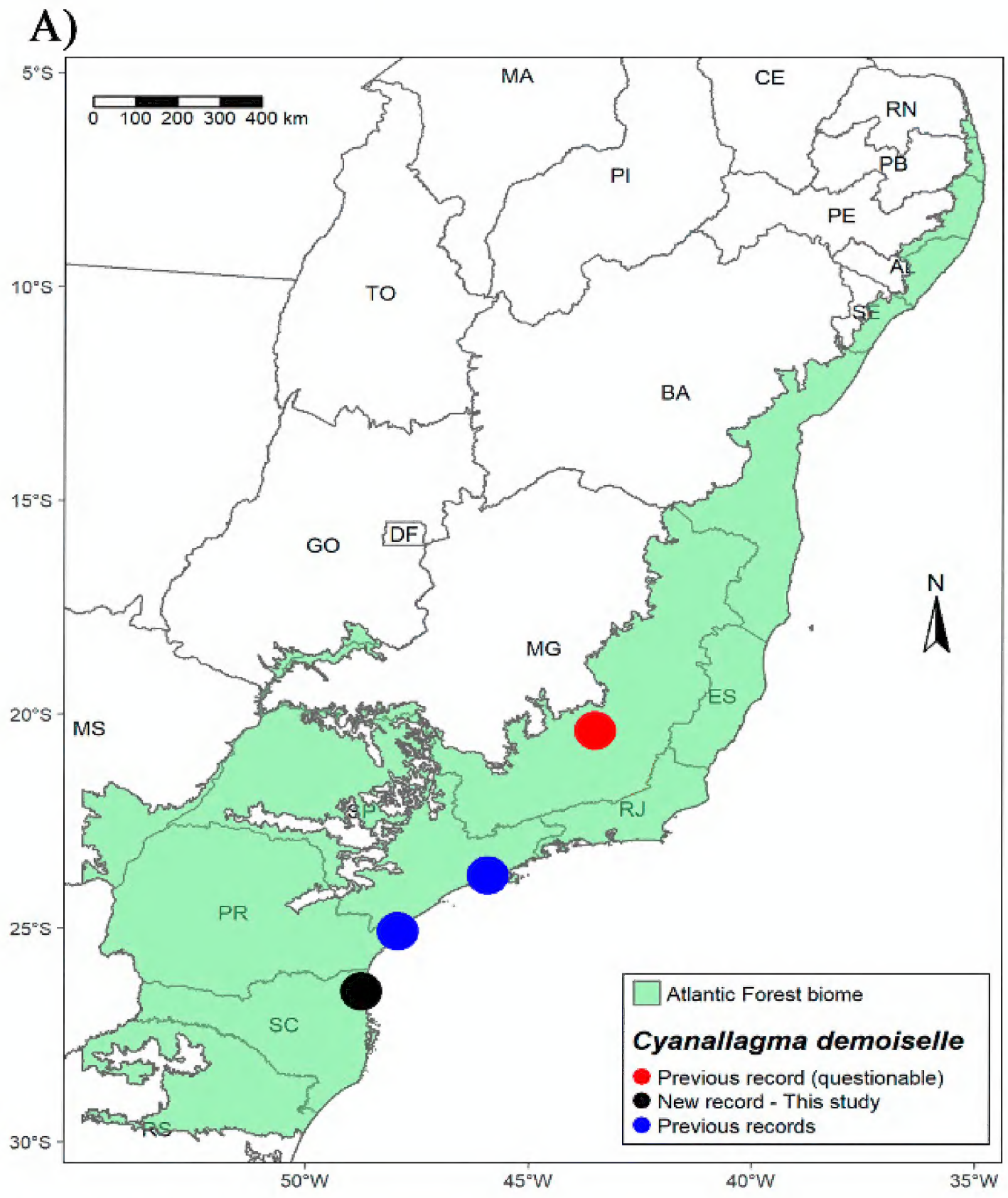

Figure 1. Occurrence records of *Cyanallagma demoiselle* Denck et al. 2023. **A.** Location of the previous and new records of *C. demoiselle*. **B.** Habitat of *C. demoiselle* in Araquari municipality (Santa Catarina state).

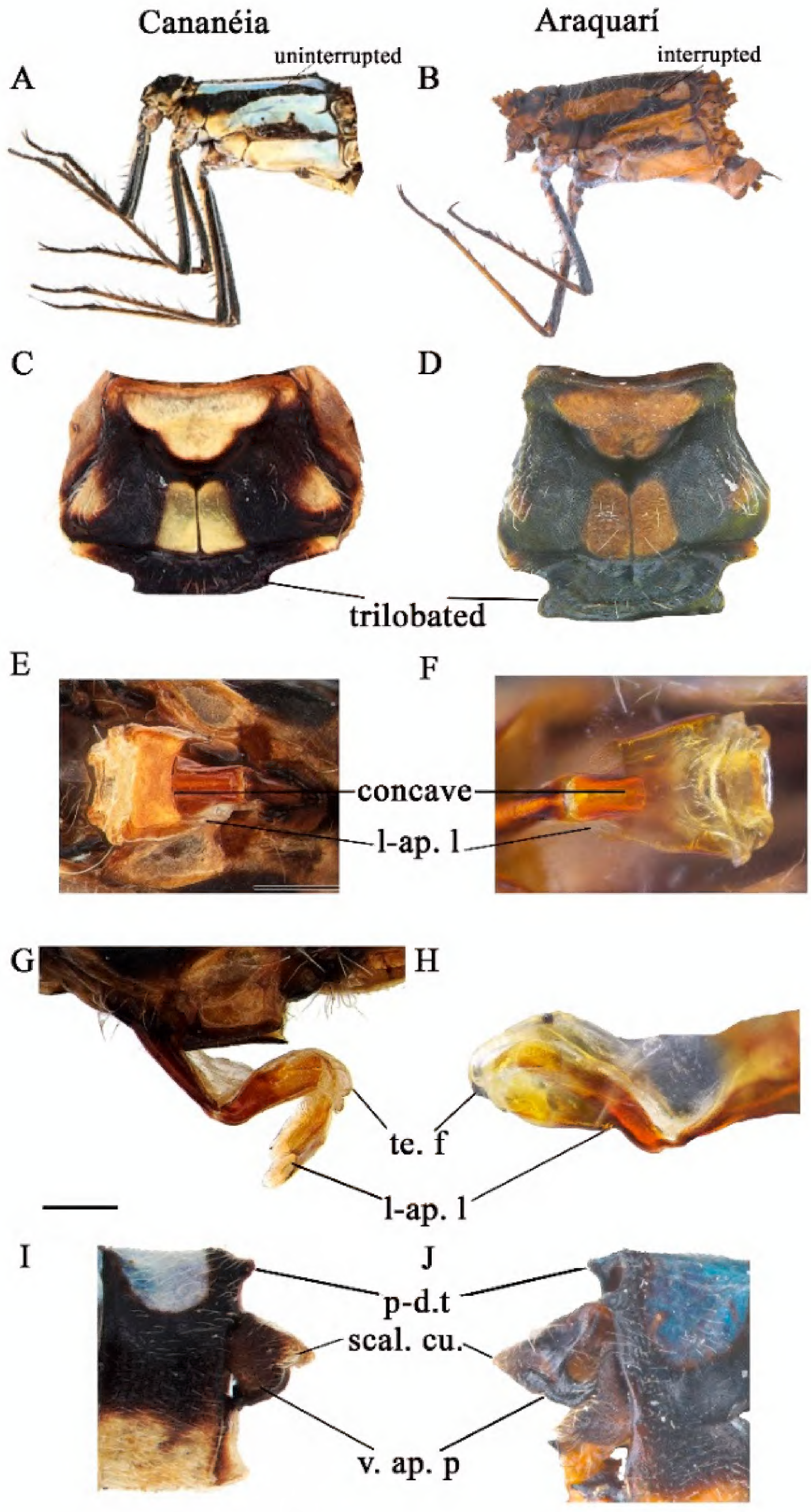

Figure 2. Male characteristics of *Cyanallagma demoiselle* Denck et al., 2023. **A, B.** Lateral view of pterothorax. **C, D.** Dorsal view of prothorax. **E, F.** Ectal view of genital ligula. **G, H.** Lateral view of genital ligula. **I, J.** Dorsolateral view of male cerci. Abbreviations: l-ap-l. = latero-apical lobe, p-d.t = posterodorsal tubercle, scal.cu = scalariform-like cuticle, te.f = terminal fold, v.ap.p. = ventro-apical process. Photos: (A, C, E, G, I) extracted from Denck et al. (2023, CC BY-NC-ND 4.0), for the holotype and a paratype male in Cananéia Municipality, São Paulo state; (B, D, F, H, J) from males collected in Araquari Municipality, Santa Catarina, Brazil.

regional inventories of Odonata in SC (Calvão et al. 2024), the record of *C. demoiselle* in the study area elevates the number of species of Odonata in the state to 151 species.

According to Denck et al. (2023), *C. demoiselle* is an exclusive element of the Atlantic Forest, inhabiting

streams, streamlets, creeks, rivers or rivulets and flooded areas near roads in drainage areas associated with Restinga formations. The municipality of Araquari is located within this biome and has many extant patches of Restinga formations (Rocha 2016); based on the available data, it can be deduced that *C. demoiselle* is thus an endemic species of Restinga-like formations. However, the specimens reported here were collected in a watershed draining into Restinga formations with altered environmental conditions due to anthropogenic activities, along with other widespread species of Odonata, common in disturbed habitats, e.g. *Erythrodiplax fusca* (Rambur, 1842), *E. umbrata* (Linnaeus, 1758), *Pantala flavescens* (Fabricius, 1798) (Libellulidae) and *Acanthagrion lancea* Selys, 1876 (Coenagrionidae; Calvão et al. 2024). Considering that coastal Restinga formations are key habitats for the maintenance of the ecological integrity of coastal freshwater habitats (Agapito et al. 2023), and that land-use changes associated with human activity negatively affect the distribution of aquatic-dependent species in the southern Brazilian coast (Moreira et al. 2020), our results call the attention to the importance of the preservation of Restinga for the conservation of aquatic insect biodiversity in the southern Atlantic Forest.

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ADDITIONAL INFORMATION

Conflict of interest

The authors declare that no competing interests exist.

Ethical statement

No ethical statement is reported.

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Author contributions

Conceptualization: MMP. Data curation: LBC, CCMP, MMP. Formal analysis: LBC, CCMP, MMP. Funding acquisition: LJ. Investigation: LBC, CCMP, MMP. Methodology: LBC, CCMP, MMP, LJ. Resources: LBC, CCMP, MMP, LJ. Supervision: EP, LJ. Visualization: LBC, CCMP, MMP. Project administration: EP, LJ. Software: MMP. Validation: LBC, MMP. Writing – original draft: MMP. Writing – review and editing: LBC, CCMP, EP, LJ.

Author ORCID iDs

Mateus M. Pires https://orcid.org/0000-0002-5728-8733
Lenize B. Calvão https://orcid.org/0000-0003-3428-8754
Cristian C. Mendoza-Penagos https://orcid.org/0000-0001-7053-5236
Eduardo Périco http://orcid.org/0000-0002-2926-6246
Leandro Juen https://orcid.org/0000-0002-6188-4386

Data availability

All data that support the findings of this study are available in the main text.

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APPENDIX

Table A1. Locations and basic environmental information of the known occurrence records of *Cyanallagma demoiselle* Denck, Ehlert and Pinto 2023. NA = non-available. * = questionable record (likely mislabeled), according to Denck et al. (2023). Environmental information in the original description of the species is extracted from Pinto (2019).

Records	Latitude	Longitude	State	Municipality	Elev. (m)	Habitat	Environment	Source
Previous	−25.0824	−047.9272	São Paulo	Cananéia	13	Sandy intertidal zone	Flooded areas with deep leaf litter	Denck et al. 2023
Previous	−23.7658	−045.9122	São Paulo	Bertioga	7		Tree-like restinga vegetation	Denck et al. 2023
Previous*	−20.3856	−043.5035	Minas Gerais	Ouro Preto	NA	NA	NA	Denck et al. 2023
This study	−26.4869	−048.7455	Santa Catarina	Araquari	12	Lotic	Partially forested stream	This study